REMARKS

The Examiner initially rejected claims 1-18 under 35 USC 112, and in particular, independent claims 1, 12, and 16 in that they refer to a method of compensating for residual aligning torque, whereas the body of the claim describe the structure of the tire. Therefore, new claims 19-31 claim a pneumatic tire per se, having certain structural features which compensate for residual aligning torque. These new claims also include the term "degrees" or the symbol therefor, at the appropriate locations.

The Office Action in rejecting the original claims relied principally upon Japan (JP 4-100706). Enclosed is a copy of an English translation of this reference. Japan '706 was also combined with Europe (EP 810104) in view of U.S. patent No. 4,298,046 and Japan (JP 63-97405), which are discussed further below.

Main independent claim 19 now defines a pneumatic tire wherein the ribs contain a plurality of <u>symmetrical</u> tread blocks which are separated by laterally extending grooves and most importantly, that the leading and trailing end walls of the tread blocks are symmetrical, that is, they are spaced equidistant with respect to a radial plane 20 which passes through a mid-point of the tread block and through the axis of rotation of the tire. This feature is shown in the attached marked-up Fig. 5. As is shown Figs. 2, 3, 4, and 9 of the application, the leading and trailing end walls of each lug are symmetrical with respect to the radial plane 20. Plane 20 also is discussed in the Specification, particularly in lines 4-8, page 6. As clearly shown in attached Figs. 3, 4, 5, and 6 of Japan '706, the lugs are

not symmetrical with respect to a plane corresponding to Applicant's plane 20 represented by line T in each of these figures. The lugs are non-symmetrical about this plane since the lugs are tilted or slanted in the same direction thereby placing the leading and trailing end walls 23-26 (Figs. 3 and 4), as well as end walls 31, 33, 36, and 37 (Figs. 5 and 6) unequally spaced or non-symmetrical with respect to line T which corresponds to plane 20 of Applicant's invention. If the sipes were placed in Applicant's lugs as taught by Japan '706, they would actually lie along plane 20 and not be angled with respect thereto and now defined in claim 19.

In summary, Japan '706 patent discloses angled sipes 28 which are formed to extend parallel to lines or planes L and M in non-symmetrical lugs. However, if the lugs were symmetrical, it would result in the sipes extending perpendicular or in line with line T and not be slanted, which is completely contrary or opposite to Applicant's tire as now set forth in claim 19. Accordingly, it is respectfully submitted that the pneumatic tire now defined in new claim 19 is not suggested in any manner or obvious in view of Japan '706.

Admittedly, Europe '104 does show sipes having a width and groove configuration similar to that set forth in some of the dependent claims now presented. However, it in no way discloses the particular arrangement of the angled sipes in the symmetrical lugs of a pneumatic tire as now set forth in new claim 19.

Furthermore, even though U.S. 4,298,046 and JP 63-97405 show lateral groove configurations which form the tread blocks which contain sipes that are

inclined to the radial direction, the sipes are not formed in opposite directions in the tread blocks of ribs located on opposite sides of a mid-circumferential plane, and are not formed in symmetrical tread blocks, as now set forth in claim 19.

In view of the above discussion and the submission of new independent claim 19 and claims 20-31 dependent therefrom, it is respectfully submitted that the application now defines patentable subject matter and are entitled to allowance.

(19) Japan Patent Office (JP)
(12) Japanese Unexamined Patent Application Publication (A)
(11) Japanese Unexamined Patent Application Publication H4-100706

(51) Int. Cl.[5]	ID. No.	Internal Filing No.	(43) Publication Date: April 2, 1992
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(54) Title of the Invention: PNEUMATIC RADIAL TIRE

(21) Japanese Patent Application H2-216355
(22) Application Filed: August 16, 1990

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SPECIFICATION

1. Title of the Invention

PNEUMATIC RADIAL TIRE

2. Scope of the Patent Claims

(1) A pneumatic radial tire having:

(a) a toroidal carcass layer under which cords extending in the radial direction are laid;

(b) a belt layer comprising at least 2 belt plies, under which cords are laid, which are arranged on the outer side in the radial direction of the carcass layer, and;

(c) tread having multiple block rows comprising many blocks that are established on the outer side in the radial direction of the belt layer and are separated in the circumferential direction on the outer surface;

where said cords that are laid under the outermost belt ply slope from one side in the circumferential direction to the other side in the circumferential direction as they progress from one side in the width direction towards the other side in the width direction;

wherein:

(i) the straight line L, which connects at least the circumferential direction center point on the radial direction inner end and the circumferential direction center point on the radial direction outer end of each block of the block rows positioned on one side end in the width direction, is sloped with respect to the tread normal line T towards one side in the circumferential direction as it progresses towards the outer side in the radial direction, and;

(ii) the straight line M, which connects at least the circumferential center point on the radial direction inner end and the circumferential direction center point on the radial direction outer end of each block of the block rows positioned on the other side end in the width direction, is sloped with respect to the tread normal line T towards the other side in the circumferential direction as it progresses towards the outer side in the radial direction.

(2) A pneumatic radial tire according to Claim 1, wherein the slope of said straight line L of all of the blocks of the block rows positioned on one side in the width direction from the equatorial plane of the tire is sloped with respect to the tread normal line T towards one side in the circumferential direction as it progresses towards the outer side in the radial direction, and said straight line M of all of the blocks of the block rows positioned on the other side in the width direction from the equatorial plane of the tire is sloped with respect to the treat normal line T towards the other side in the circumferential direction as it progresses towards the outer side in the radial direction.

3. Detailed Description of the Invention

Industrial Field of Application

This invention is related to a pneumatic radial tire that improves linearity.

Prior Art

In general, pneumatic radial tires have a belt layer that comprises at least 2 belt plies under which cords are laid, but such belt ply cords slope with respect to the equatorial plane of the tire, so the linearity decreases when the pneumatic radial tire receives a self-aligning torque induced by these sloping cords – in particular, by cords of belt plies that are arranged on the outermost side.

Therefore, as described in Japanese Unexamined Patent Application Publication S54-55902, for example, tires have been proposed in which the direction of the tread pattern – that is, the block extending direction – is established as the opposite direction of the outermost belt ply cord direction, and the lateral force based on the aforementioned self-aligning torque is thereby offset by the lateral force induced by the tread pattern, improving the linearity of the pneumatic tire.

Problem to be Solved by the Invention

However, while pneumatic radial tires such as that described above attempt to eliminate the self aligning torque of the belt plies with the tread pattern, the lateral force resulting from such a tread pattern is small, so there is the problem that such tires are not able to sufficiently improve linearity.

The objective of this invention is to provide a pneumatic radial tire that is able to dramatically improve linearity performance by offsetting with certainty the self-aligning torque induced by the outermost belt ply cords.

Means for Solving the Problem

In a pneumatic radial tire having (a) a toroidal carcass layer under which cords extending in the radial direction are laid, (b) a belt layer comprising at least 2 belt plies, under which cords are laid, which are arranged on the outer side in the radial direction of the carcass layer, and (c) tread having multiple block rows comprising many blocks that are established on the outer side in the radial direction of the belt layer and are separated in the circumferential direction on the outer surface, wherein the aforementioned cords that are laid under the outermost belt ply slope from one side in the circumferential direction to the other side in the circumferential direction as they progress from one side in the width direction towards the other side in the width direction, this objective can be achieved by (i) sloping the straight line L, which connects at least the circumferential direction center point on the radial direction inner end and the circumferential direction center point on the radial direction outer end of each block of the block rows positioned on one side end in the width direction, with respect to the tread normal line T towards one side in the circumferential direction as it progresses towards the outer side in the radial direction, and (ii) sloping the straight line M, which connects at least the circumferential center point on the radial direction inner end and the circumferential direction center point on the radial direction outer end of each block of the block rows positioned on the other side end in the width direction, with respect to the tread normal line T towards the other side in the circumferential direction as it progresses towards the outer side in the radial direction.

Here, as described in Claim 2, it is also permissible to slope the aforementioned straight line L of all of the blocks of the block rows positioned on one side in the width direction from the equatorial plane of the tire with respect to the tread normal line T towards one side in the circumferential direction as it progresses towards the outer side in the radial direction, and slope the aforementioned straight line M of all of the blocks of the block rows positioned on the other side in the width direction from the equatorial plane of the tire with respect to the treat normal line T towards the other side in the circumferential direction as it progresses towards the outer side in the radial direction.

Operation

Now, it is assumed that the pneumatic radial tire of this invention is moving in a straight line. At this time, the belt plies that are positioned inside the ground connecting regions of this tire receive a force and expand and contract, but the belt plies undergo in-plane shear deformation due to this expansion and contraction. This shear deformation – in particular, the shear deformation of the outermost belt ply – deforms the tread rubber and induces a self-aligning torque on the aforementioned tire. Here, the cords that are laid under the outermost belt ply are, when viewed from the rotational axis of the tire, sloped from one side in the circumferential direction to the other side in the circumferential direction as they progress from one side in the width direction to the other side in the width direction, so, when viewed from above, a counterclockwise self-aligning torque acts upon the tire. On the other hand, with this invention, straight line L, which connects at least the circumferential direction center point on the radial direction inner end and the circumferential direction center point on the radial direction outer end of each block of the block rows positioned on one side end in the width direction from among the blocks that are formed on the tread outer surface of the aforementioned tire, is sloped with respect to the tread normal line T towards one side in the circumferential direction as it progresses towards the outer side in the radial direction,

and straight line M, which connects at least the circumferential center point on the radial direction inner end and the circumferential direction center point on the radial direction outer end of each block of the block rows positioned on the other side end in the width direction, is sloped with respect to the tread normal line T towards the other side in the circumferential direction as it progresses towards the outer side in the radial direction. Therefore, these blocks that slope towards one side in the circumferential direction deform when they take a load from the tire, causing the slope towards one side in the circumferential direction to become even larger (this results in displacement towards the other side in the circumferential direction from the perspective of the tire). On the other hand, the blocks that slope towards the other side in the circumferential direction deform when they take a load from the tire, causing the slope towards the other side in the circumferential direction to become even larger (this results in displacement towards the first side in the circumferential direction from the perspective of the tire). Here, the blocks that slope towards one side in the circumferential direction are at least the blocks of block rows positioned on one side end in the width direction, and the blocks that slope towards the other end in the circumferential direction are at least the blocks of block rows positioned on the other side end in the width direction, so, when viewed from above, a clockwise torque is applied to the tire. In this way, because the self-aligning torque that is induced by the outermost belt ply is a torque in the direction opposite of the torque that is applied by the sloping blocks, they offset one another, resulting in improvement of tire linearity performance.

Moreover, if the tire is configured as described in Claim 2, many blocks deform and apply to the tire a torque in the direction opposite of the self-aligning torque, so the tire linearity performance improves even further.

Examples of Embodiment

Hereafter, a first embodiment of this invention will be explained with reference to the drawings.

In Figures 1 and 2, 1 is a pneumatic radial tire, and this tire 1 has a pair of beads 2 and a toroidal carcass layer 3 in which both ends in the width direction are folded back on beads 2. This carcass layer 3 consists of at least 1 carcass ply 5 (1 carcass ply is used in this embodiment) under which many cords 4 that extend in the radial direction (meridional direction) are laid. Belt layer 7 is arranged on the outer side in the radial direction of this carcass layer 3, and this belt layer 7 is formed by layering at least 2 belt plies (2 belt plies 8 and 9 are used in this embodiment). Many cords 10 and 11 are laid inside belt plies 8 and 9, respectively, and these cords 10 and 11 extend in opposite directions. In other words, when viewed from the rotational axis of tire 1, cords 10 of the outermost belt ply 8 slope from one side in the circumferential direction to the other side in the circumferential direction as they progress from one side in the width direction towards the other side in the width direction. Conversely, cords 11 of the inner belt ply 9 slope from the other side in the circumferential direction to the first side in the circumferential direction as they progress from one side in the width direction towards the other side in the width direction. Moreover, these cords 10 and 11 intersect at angles within the range of 15 to 40 degrees with respect to the equatorial plane 15 of the tire. 18 is tread that is arranged on the outer side in the radial direction of belt layer 7, and multiple primary grooves 19 (4 grooves are used in this embodiment) that extend in the circumferential direction are formed on the outer surface of this tread 18. These primary grooves 19 are arranged nearly equidistantly in the width direction. Moreover, multiple lateral grooves 20 that extend in approximately the width direction are formed on the outer surface of this tread 18, and these lateral grooves 20 are arranged approximately equidistantly in the circumferential direction. As a result, multiple block rows 22 (5 rows are used in this embodiment) comprising many blocks 21 that are separated in the circumferential direction are formed on the outer surface of this tread 18 due to these primary grooves 19 and lateral grooves 20. Furthermore, from among these block rows 22, by sloping one side wall 23 of the circumferential direction and the other side wall 24 of the circumferential direction of at least blocks 21a and b,

which constitute the block rows positioned on one side end in the width direction (in this embodiment, this is not only block row 22a that is positioned on one side end in the width direction, but both of the block rows 22a and b that are positioned on one side in the width direction from the equatorial plane 15 of the tire), towards one side in the circumferential direction as shown in Figure 3, straight line L, which connects the circumferential direction center point R on the radial direction inner end and the circumferential direction center point S on the radial direction outer end of these blocks 21a and b, is sloped with respect to the normal line T of tread 18 towards one side in the circumferential direction as it progresses towards the outer side in the radial direction. Moreover, from among these block rows 22, by sloping one side wall 25 of the circumferential direction and the other side wall 26 of the circumferential direction of at least blocks 21d and e, which constitute the block rows positioned on the other side end in the width direction (in this embodiment, this is not only block row 22e that is positioned on the other side end in the width direction, but both of the block rows 22d and e that are positioned on the other side in the width direction from the equatorial plane 15 of the tire),

towards the other side in the circumferential direction as shown in Figure 4, straight line M, which connects the circumferential direction center point U on the radial direction inner end and circumferential direction center point V on the radial direction outer end of these blocks 21d and e, is sloped with respect to the normal line T of tread 18 towards the other side in the circumferential direction as it progresses towards the outer side in the radial direction. Here, it is preferable for the intersection angle G of the aforementioned straight lines L and M and the normal line T to be within the range between 5 and 30 degrees. The reason for this is that if this intersection angle G is less than 5 degrees, then the amount of deformation of blocks 21a, b, d, and e when they take the load of tire 1 is small, making it impossible to sufficiently offset the self-aligning torque with the outermost belt ply 8. On the other hand, if this intersection angle G exceeds 30 degrees, then edges with small angles are formed on the radial direction outer ends of blocks 21a, b, d, and e, and there is the risk that these edges will be lost when the tire is moving. <u>Moreover, sipes 28 are formed on these blocks 21a, b, d, and e, and these sipes 28 extend parallel to the aforementioned straight lines L and M.</u>

Next, the operation of the first embodiment of this invention will be explained.

Now, it is assumed that tire 1 described previously is moving in a straight line. At this time, the belt plies 8 and 9 that are positioned inside the ground connecting regions of this tire 1 receive a force and expand and contract, but belt plies 8 and 9 undergo in-plane shear deformation due to this expansion and contraction. This shear deformation – in particular, the shear deformation of the outermost belt ply 8 – affects and deforms tread 18, and induces a self-aligning torque on tire 1. Here, cords 10 that are laid under the outermost belt ply 8 are, when viewed from the rotational axis of tire 1, sloped from one side in the circumferential direction to the other side in the circumferential direction as they progress from one side in the width direction to the other side in the width direction, so, when viewed from above, a counterclockwise self-aligning torque acts upon the tire 1. On the other hand, in this embodiment, from among the blocks 21 that are formed on the outer surface of tread 18 of this tire 1, straight line L of each block 21a and b of block rows 22a and b that are positioned on one side in the width direction from the equatorial plane 15 of the tire is sloped with respect to the normal line T of tread 18 towards one side in the circumferential direction, and straight line M of each block 21d and e of block rows 22d and e that are positioned on the other side in the width direction from the equatorial plane 15 of the tire is sloped with respect to the normal line T of tread 18 towards the other side in the circumferential direction. Therefore, these blocks 21a and b that slope towards one side in the circumferential direction deform when they take a load from tire 1, causing the slope towards one side in the circumferential direction to become even larger. On the other hand, blocks 21d and e that slope towards the other side in the circumferential direction likewise deform, causing the slope towards the other side in the circumferential direction to become even larger. Here, the outer ends in the radial direction of blocks 21a, b, d, and e are grounded and cannot be displaced, so tire 1 on one side in the width direction from the equatorial plane 15 of the tire is displaced to the other side in the circumferential direction due to the deformation of blocks 21a and b. Furthermore, tire 1 on the other side in the width direction from the equatorial plane 15 of the tire is displaced to the first side in the circumferential direction due to the deformation of blocks 21d and e. Therefore, when viewed from above, clockwise torques are applied to tire 1 due to the deformation of these blocks 21. Here, because the self-aligning torque that is induced by the outermost belt ply 8 is a torque in the direction opposite of the torques that are applied by the deformation of these blocks 21a, b, d, and e, these torques offset one another, resulting in improvement of tire linearity performance. Moreover, as for the torques applied to tire 1 from these blocks 21, the torques from blocks 21a and e of block rows 22a and e, which are positioned on one side end in the width direction and the other side end in the width direction that are furthest from the equatorial plane 15 of the tire, are the largest. Therefore, it is permissible to slope only blocks 21a and e of one side in the width direction and the other side in the width direction as described previously, but in this embodiment, blocks b and d of the other block rows – in other words, block rows 22b and d – are likewise sloped, resulting in further improvement of the linearity performance of tire 1.

Figure 5 is a drawing that shows a second embodiment of this invention. In this embodiment, one side wall 31 in the circumferential direction of blocks 30 in block rows that are positioned on one side in the width direction is formed parallel to the normal line T of tread 32, and the other side wall 33 in the circumferential direction is sloped with respect to the normal line T towards one side in the circumferential direction. By doing so, the straight line L of these blocks 30 is sloped with respect to the normal line T towards one side in the circumferential direction.

In addition, the blocks of block rows that are positioned on the other side end in the width direction are not shown in the drawing, but they are sloped in the direction opposite of blocks 30 – that is, towards the other side in the circumferential direction.

Figure 6 is a drawing that shows a third embodiment of this invention. In this embodiment, one side wall 36 in the circumferential direction and the other side wall 37 in the circumferential direction of blocks 35 in block rows that are positioned on one side in the width direction are projected stepwise towards one side in the circumferential direction. By doing so, the straight line L of these blocks 35 is sloped with respect to the normal line T towards one side in the circumferential direction. In addition the blocks of block rows that are positioned on the other side end in the width direction are not shown in the drawing, but they are sloped in the direction opposite of blocks 35 – that is, towards the other side in the circumferential direction.

Next, a test example will be explained. In this test example, a test tire having the blocks explained in the first embodiment (both the intersection angle G and the slope angle of sipes were 15 degrees) and a comparison tire having blocks with an intersection angle of 0 degrees – in other words, blocks in which one side wall in the circumferential direction and the other side wall in the circumferential direction are both parallel to the normal line T – were prepared. Here, the sizes of both tires were 195/65 R15, and the intersection angles of the cords that were laid under the outermost belt plies with respect to the equatorial planes of the tires were all 22 degrees. Next, after an internal pressure of 2.2 kg/cm^2 was filled into both tires, they were mounted onto 2000 cc-class automobiles. The test drivers drove the automobiles in straight lines at 60 km/h for 100 m without holding onto the steering wheels, and the amounts of deviation (m) at the end of the 100 m runs were measured. As a result, while the comparison tire deviated 1.1 m to the left, the linearity performance was markedly improved with the test tire, as the amount of deviation to the left was reduced to 0.1 m.

Effect of the Invention

As described above, through this invention, it is possible to dramatically improve linearity performance by offsetting with certainty the self-aligning torque induced by the outermost belt ply cords.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a meridional cross sectional view showing the first embodiment of this invention. Figure 2 is an arrow perspective view of the partially broken X–X arrows in Figure 1. Figure 3 is an arrow perspective cross sectional view of Y–Y in Figure 2. Figure 4 is an arrow perspective cross sectional view of Z–Z in Figure 2. Figure 5 is the same type of cross sectional view as Figure 3 that shows the second embodiment of this invention. Figure 6 is the same type of cross sectional view as Figure 3 that shows the third embodiment of this invention.

3... Carcass layer　　4... Cords
7... Belt layer　　8, 9... Belt plies
10, 11... Cords　　18... Tread
21... Blocks　　22... Block rows
R, U... Circumferential direction center points
S, V... Circumferential direction center points
L, M... Straight lines　　T... Normal lines

Patent applicant: Bridgestone Corporation
Representative: Patent Attorney Toshio Tada

[see source for figures]

Figure 2

Other side in the circumferential direction

One side in the width direction

Other side in the width direction

One side in the circumferential direction

4: Cords
10, 11: Cords
21: Blocks
22: Block rows

Figure 3

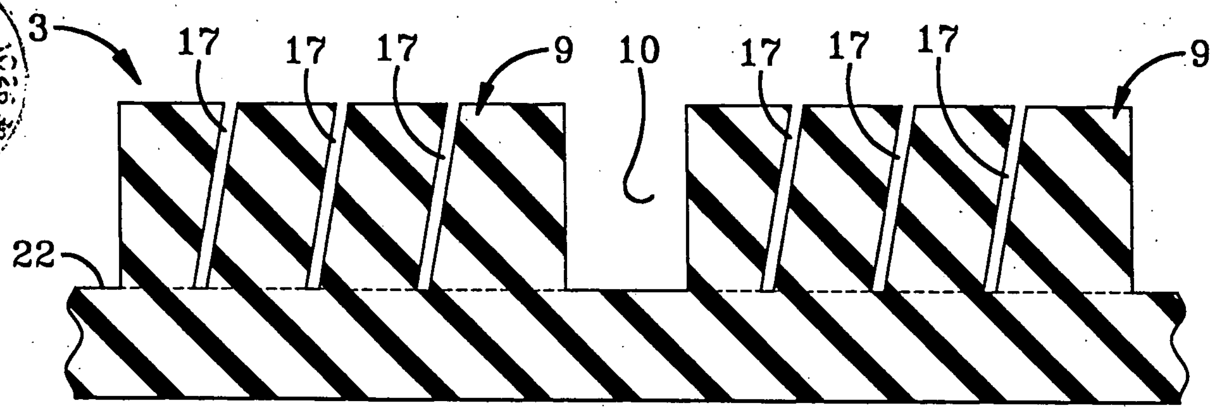
R: Circumferential direction center point
S: Circumferential direction center point
L: Straight line
T: Normal line

Figure 4

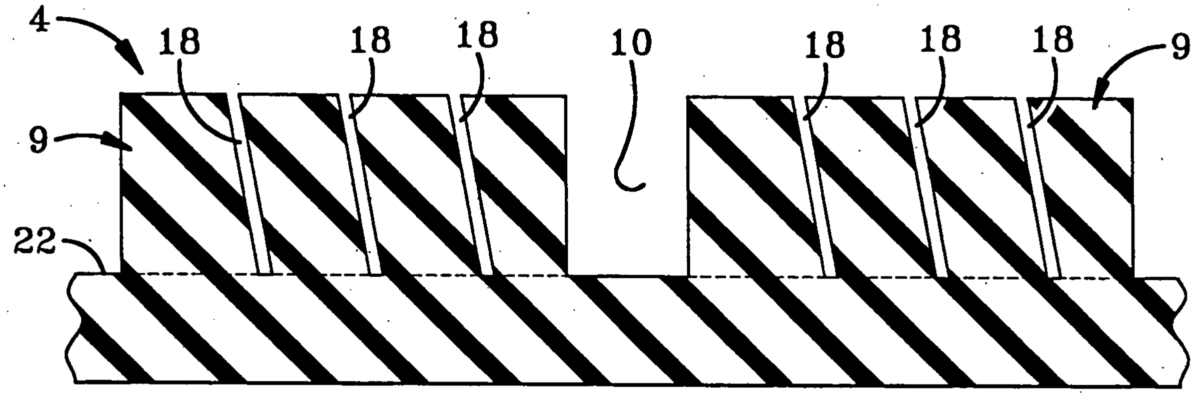
U: Circumferential direction center point
V: Circumferential direction center point
M: Straight line

Figure 5

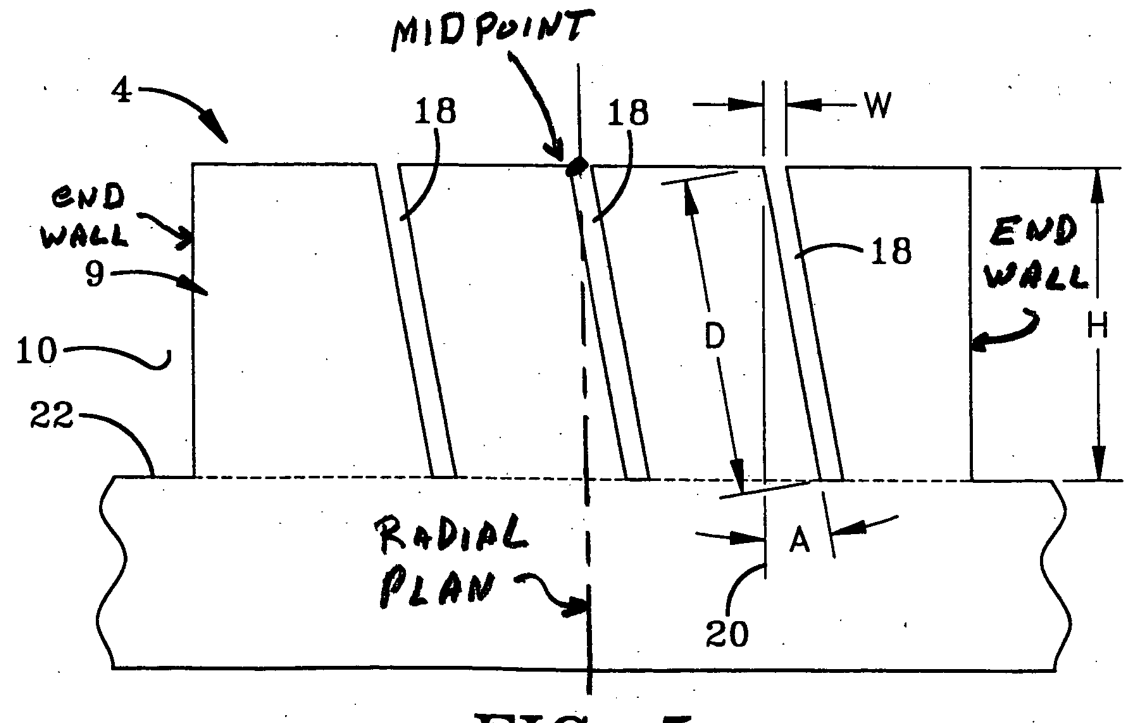
Figure 6



FIG—3

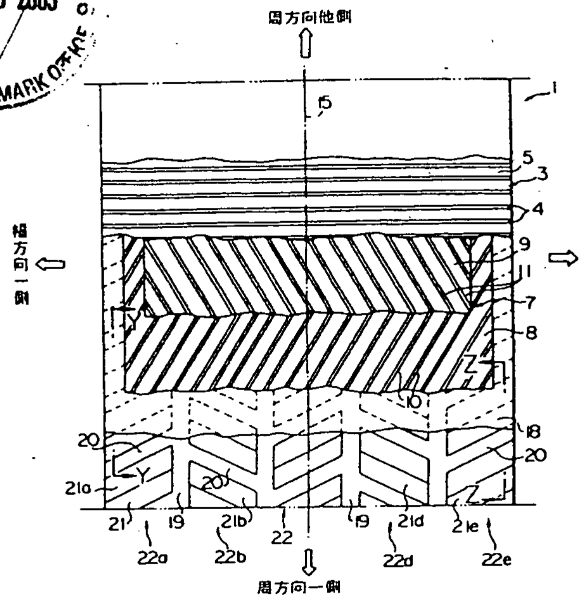


FIG—4



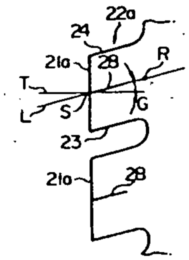
FIG—5

第 2 図



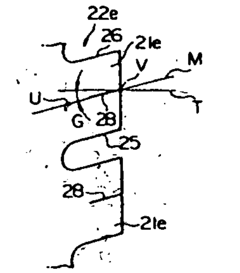
4：コード
10, 11 ：コード
21：ブロック
22：ブロック列

第 3 図



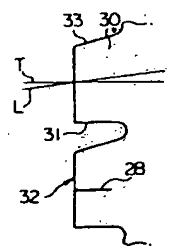
R：周方向中央点
S：周方向中央点
L：直線
T：法線

第 4 図



U：周方向中央点
V：周方向中央点
M：直線

第 5 図



第 6 図